Fujitsu's Approach to Electricity Systems Reform through Electricity Retail Solutions

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Major reforms in the Japanese electric power industry have been mapped out by the Expert Committee on Electricity Systems Reform of the Ministry of Economy, Trade and Industry (METI). They include the adoption of smart meters, the full liberalization of the electricity retail business, and the unbundling of the power-generation and transmission-and-distribution departments in power companies. Fujitsu has leveraged its extensive know-how in electric-power sales and systems to develop electricity retail solutions that can respond promptly to changes in the business environment. Nevertheless, the coming reforms in electricity systems will create a variety of issues, and new mechanisms are needed to solve them. This paper looks at the changes that we forecast the reforms will make to the electricity market. Our forecast is based on overseas examples and the unique features of the Japanese market environment. It also clarifies the directions that solutions should take in the face of those changes and describes the ideas and mechanisms behind those solutions.

1. Introduction

In February 2013, the Expert Committee on Electricity Systems Reform of the Ministry of Economy, Trade and Industry (METI) compiled a report on reforming Japan's electricity system. This report called for the introduction of smart meters, the full liberalization of the electricity market, and the legal separation (unbundling) of the power-generation and transmission-and-distribution departments in power companies to initiate reform in the electric power industry. It addressed three points in particular.[1)]

The first point is the liberalization of the electricity retail market. This includes free entry into the retail market, enabling households and other small-scale consumers to select power suppliers and power sources as desired. It also includes freeing power companies from power-supply obligations and rate regulations so that they can provide a variety of rate plans addressing consumer needs (referred to below as "full retail liberalization").

The second point is the proactive use of market functions to stimulate the power-generation market. In particular, it calls for the abolishment of wholesale regulations that are no longer needed due to full retail liberalization.

Finally, the third point is the nationwide expansion and neutralization of the power transmission and distribution sector. This includes establishment of the proposed Organization for Nationwide Coordination of Transmission Operators (ONCT), which will formulate a wide-area system plan (i.e., on a national level) across traditional power-supply areas and adjust supply and demand as needed. It also includes neutral operation of the transmission and distribution grid and the splitting of power companies by legally unbundling their transmission-and-distribution departments so that multiple operators can use the transmission and distribution grid (referred to below as "generation/transmission unbundling").

A roadmap based on the electricity systems reform report described above has been prepared up to 2020 (**Figure 1**). In this paper, we introduce Fujitsu's approach to reforming Japan's electricity systems through the provision of retail solutions.

2. Market changes and solutions

We forecast the changes that electricity systems reform in Japan will make to the electric power industry

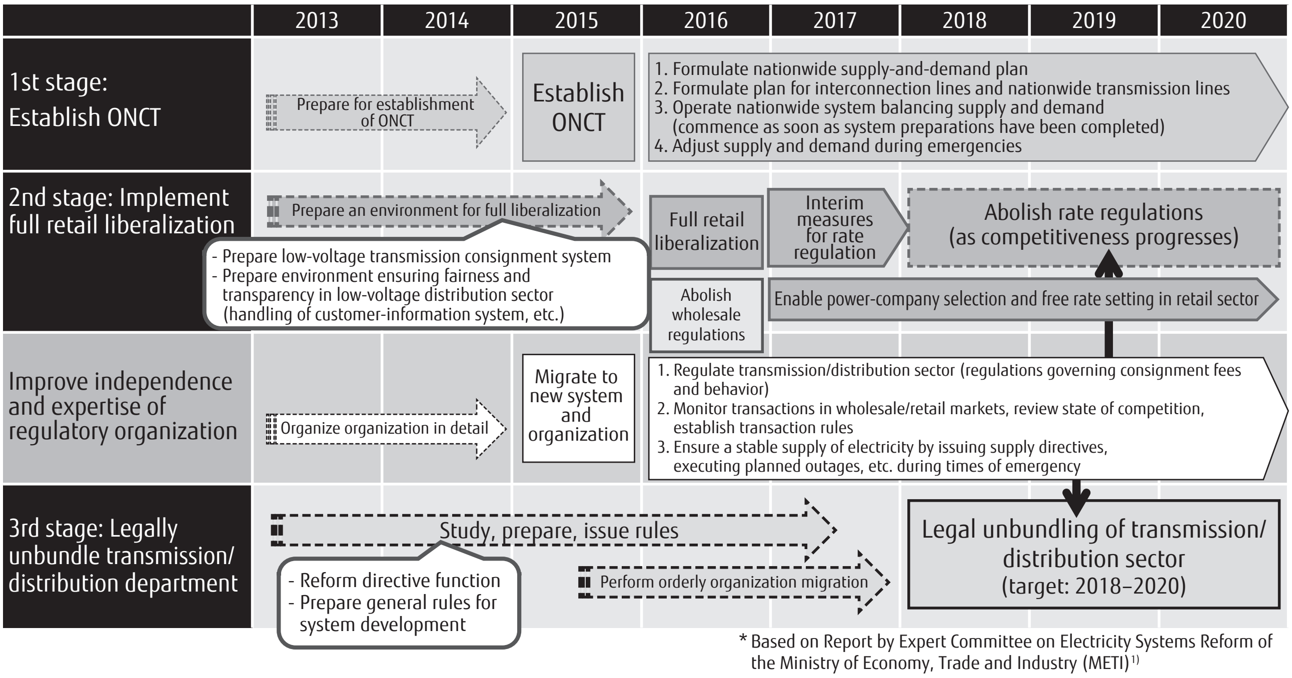

Figure 1
Roadmap of Japan's electricity systems reform.

to enable us to clarify future problems in the retail departments of power companies and visualize the directions that solutions should take. Our forecast takes into account prior trends in overseas markets and the market environment unique to Japan.

Our assessment of industry trends in overseas markets[2)] where full retail liberalization and generation/transmission unbundling have already come about highlighted two likely changes. These changes are not limited to the electric power industry—they are likely to occur in any market environment due to deregulation.

1) Appearance of new entrants and consolidation of operators

In the initial period following the introduction of electricity systems reforms, we can expect new entrants from a variety of industries. However, over time, there will be a consolidation of operators centered on large and heavily capitalized power and gas companies that already exist.

2) Provision of new rate plans and services

A variety of rate plans such as time of use (TOU), critical peak pricing (CPP), and real time pricing (RTP) will be offered by the market. Diverse services, such as energy-saving consulting, will also be offered.

Although no final decision has yet been made on how existing power companies will be split up, we assume that each will be split into three companies: a power-generation company, a (neutral) transmission-and-distribution company, and a retail company. While each of these companies will require sales operations and business systems, here we focus on sales operations for retail companies.

We consider three measures targeting the sales operations of a retail company to be essential:

1) Develop strong sales abilities
2) Develop flexible business operations that can adapt to the market environment
3) Improve productivity of people and things.

We consider that electricity retail solutions for supporting these measures should take corresponding directions:

1) Strengthen sales abilities and improve services
2) Adapt to business changes
3) Apply new information and communications technology (ICT) to improve productivity.

The following sections describe the ideas and mechanisms behind these retail solutions.

3. Mechanisms supporting new rate plans and services

The core system of an electricity retail system must be able to perform a range of tasks, from accepting service applications to billing consumers and receiving payment. Systems of this type have already been constructed.

However, given that full retail liberalization should lead to severe competition in the market and that smart meters for automatically reading and transmitting power usage at regular intervals should become common, we envision the need for setting various rates in accordance with consumer lifestyles and business needs.

Accordingly, the core system must incorporate two mechanisms so that it can strengthen sales abilities and improve services.

1) Mechanism for calculating charges for various rate plans
2) Mechanism for collective billing of various services

3.1 Mechanism for calculating charges for various rate plans

3.1.1 Dealing with diverse TOU rate plans

It is common in existing TOU rate systems to specify charges for up to three time periods (e.g., daytime, evening, night). Therefore, program development is often necessary whenever a new rate plan is to be added to the system.

This is because, in the conventional system of calculating charges, a meter reader (a person) records the meter reading once a month, and the system uses the difference between the previous month's reading and the current month's reading to determine the amount of electricity used (i.e., "usage") and calculate the charge. This does not support flexible determination of usage by time period. The difference between the conventional and new methods of calculating usage is shown in **Figure 2**. This figure shows, in particular, the difference between the conventional difference method and the summation method for smart meters.

The introduction of diverse TOU rate plans will require flexible determination of usage by time period. A mechanism is thus needed for determining usage by time period on the basis of smart-meter readings taken at regular intervals and then adding up the usage by time period. A model for doing this is shown in **Figure 3**. In this model, the season and the time period can be determined from the date and time of the reading, which means that usage can be calculated in day and month units by referring to a season/time-period definition table.

3.1.2 Dealing with diverse CPP

In addition to the introduction of diverse TOU rate plans, new peak pricing rates will likely be introduced. For example, special unit prices may be set for power usage over a specific amount or for usage during a specific time period. A mechanism is thus needed that can transform a base usage curve (load curve) under

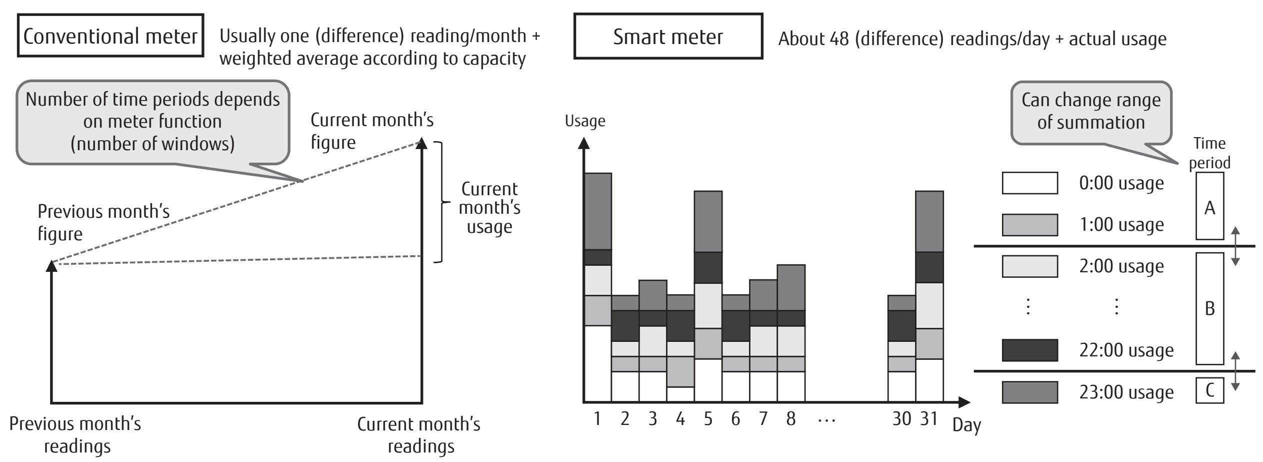

Figure 2
Difference between conventional and new usage calculation methods.

Readings collected at place of usage (smart meter)

Meter ID key (metering unit no.)	Reading Date/Time	Reading Type	Reading Class	Change Class	Reading	Collection date/time
22222	2011/07/01 00:00	Scheduled	Automatic	Summer, Monthly	10	2011/07/01 00:02
...	...	...	...	...	...	...
22222	2011/07/20 00:30	Scheduled	Automatic		330	2011/07/20 00:32
...	...	...	...	...	...	...
22222	2011/07/20 23:30	Scheduled	Automatic		345	2011/07/20 23:32
22222	2011/07/21 00:00	Scheduled	Automatic		346	2011/07/21 00:02
...	...	...	...	...	...	...
22222	2011/07/23 00:30	Scheduled	Automatic		390	2011/07/23 00:32
...	...	...	...	...	...	...
22222	2011/07/23 23:30	Scheduled	Automatic		406	2011/07/23 23:32
22222	2011/07/24 00:00	Scheduled	Automatic		410	2011/07/24 00:02
...	...	...	...	...	...	...
22222	2011/08/01 00:00	Scheduled	Automatic	Monthly	550	2011/08/01 00:02

Reference

Season/Time-period definition table

Contract type	Season	Weekday/ Holiday	From (period)	To (period)	From (time)	To (time)	Index
2-time-period-based lighting	All	All	01/01	12/31	07:00	23:00	Daytime
2-time-period-based lighting	All	All	01/01	12/31	23:00	07:00	Nighttime
Season/Time-based lighting 1	Summer	Weekday	07/01	09/30	09:00	17:00	Summer/Weekday/Daytime
Season/Time-based lighting 1	Summer	Weekday	07/01	09/30	07:00	09:00	Summer/Weekday living
Season/Time-based lighting 1	Summer	Weekday	07/01	09/30	17:00	23:00	Summer/Weekday living
Season/Time-based lighting 1	Summer	Weekday	07/01	09/30	23:00	07:00	Summer/Weekday/Nighttime
Season/Time-based lighting 1	Summer	Holiday	07/01	09/30	07:00	23:00	Summer/Holiday living
Season/Time-based lighting 1	Summer	Holiday	07/01	09/30	23:00	07:00	Summer/Holiday/Nighttime
Season/Time-based lighting 1	Non-summer	Weekday	10/01	06/30	09:00	17:00	Non-summer/Weekday/Daytime
Season/Time-based lighting 1	Non-summer	Weekday	10/01	06/30	09:00	17:00	Non-summer/Weekday/Daytime
Season/Time-based lighting 1	Non-summer	Weekday	10/01	06/30	07:00	09:00	Non-summer/Weekday living
Season/Time-based lighting 1	Non-summer	Weekday	10/01	06/30	17:00	23:00	Non-summer/Weekday living
Season/Time-based lighting 1	Non-summer	Weekday	10/01	06/30	23:00	07:00	Non-summer/Weekday/Nighttime
Season/Time-based lighting 1	Non-summer	Holiday	10/01	06/30	07:00	23:00	Non-summer/Holiday living
Meter-rate lighting B	All	All	01/01	12/31	00:00	00:00	All day

Calculate

Daily usage data for 2-time-period-based lighting

Contract	Reading year/month/date	Index	Usage
1000	2011/07/20	Daytime	6
1000	2011/07/20	Nighttime	10

Calculate

Calculate

Daily usage data for season/time-based lighting 1

Contract	Reading year/month/date	Index	Usage
1000	2011/07/20	Summer/weekday/daytime	4
1000	2011/07/20	Summer/weekday living	9
1000	2011/07/20	Summer/weekday/nighttime	3
...	...	...	...
1000	2011/07/23	Summer/holiday living	13
1000	2011/07/23	Summer/holiday/nighttime	7

Calculate

Daily usage data for meter rate lighting B

Contract	Reading year/month/date	Index	Usage
1000	2011/07/20	All day	16

Figure 3
Example of usage summation method.

certain conditions for a particular process and generate new usage curves. Specifically, functions are needed for combining process load curves such as those shown in **Figure 4** to enable the provision of flexible rate plans without having to develop separate rate-plan programs as is currently required.

This concept can be expressed in formula form. A rate calculation engine for implementing this formula remains to be constructed.

$$y = (f_1(x) \times a_1) + (f_2(x) \times a_2) + \ldots + (f_n(x) \times a_n)$$

x: usage of specific consumer at a specific time
f (x): function for transforming usage
a: usage unit price at a specific time
y: total charge

3.1.3 Dealing with RTP

One aim of the reforms is to expand the procurement of electric power from wholesale power exchange markets. We thus envision a retail market that provides real-time rates associated with the price in wholesale markets. A rate plan thus becomes simply a unit price that adds a certain profit to the cost of procuring electricity from wholesale markets.

Implementing such a plan will require four functions:

1) Formulation of power-generation plans for one's

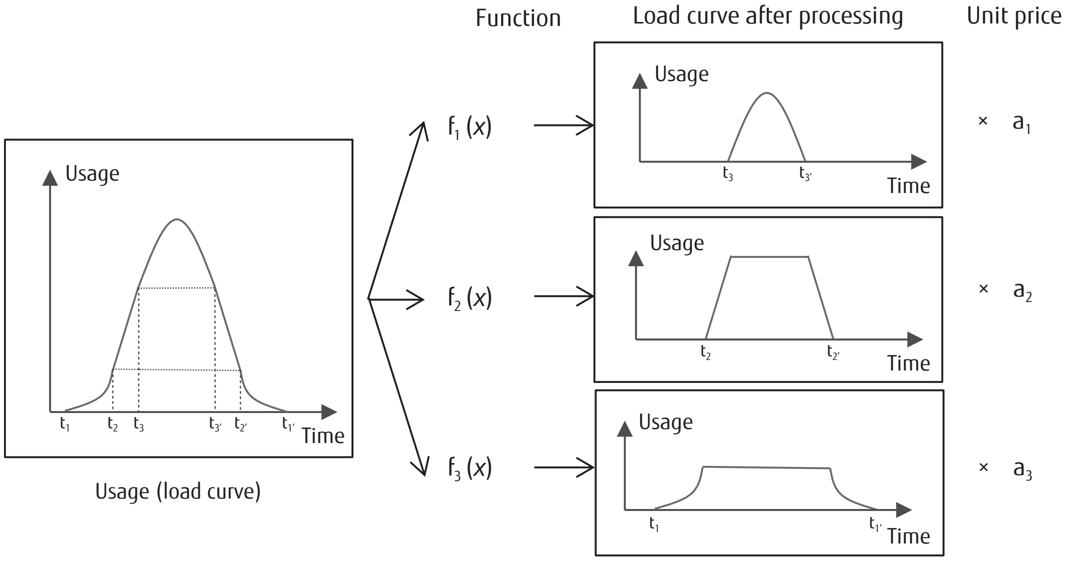

Figure 4
Rate calculation using load-curve-processing functions.

own power supply and another company's power supply and forecasting consumer demand

2) Submission of bids to wholesale markets to make up for shortages of electric power
3) Setting of unit prices that add on a certain profit to the cost of one's own power supply, to the cost of procuring electricity from another company's power supply, and to the contract price in wholesale markets
4) Multiplication of the above unit prices by actual usage to calculate the charge to the consumer.

The concept of real-time rate calculation using the above functions is shown in **Figure 5**.

3.2 Mechanism for collective billing of various services

Examples of prior reform[3] in the European and American electricity markets show that new entrants in Japan will likely come from the gas industry following full retail liberalization. Gas companies will enter the business on a dual-fuel basis (the selling of electricity and gas/heat).

Consideration of the situation in Japan indicates that carriers engaged in the fixed-communications business[4] and companies engaged in the home construction business[5] will enter the market by providing an electrical power service as an option to their base businesses.

Retail power companies will likely compete with these entrants by providing non-power services such as gas and communication services.

The core retail system will thus require a mechanism for calculating the charges for individual services and billing them all together. One scheme for achieving such a multi-service mechanism is to construct the system with a 1:*n* relationship between payment information and contract information using a conceptual data model.

4. Mechanism for increasing business efficiency: toward efficient collaboration between group companies

As a result of full retail liberalization and generation/transmission unbundling, the business operations of existing retail power companies will have to incorporate improved productivity in people and things if they are to hold their own in the face of new competing operators. New types of ICT to improve productivity should therefore be applied to a company's core system, as described below.

The introduction of generation/transmission unbundling reform means that the transmission-and-distribution department in an electric power company

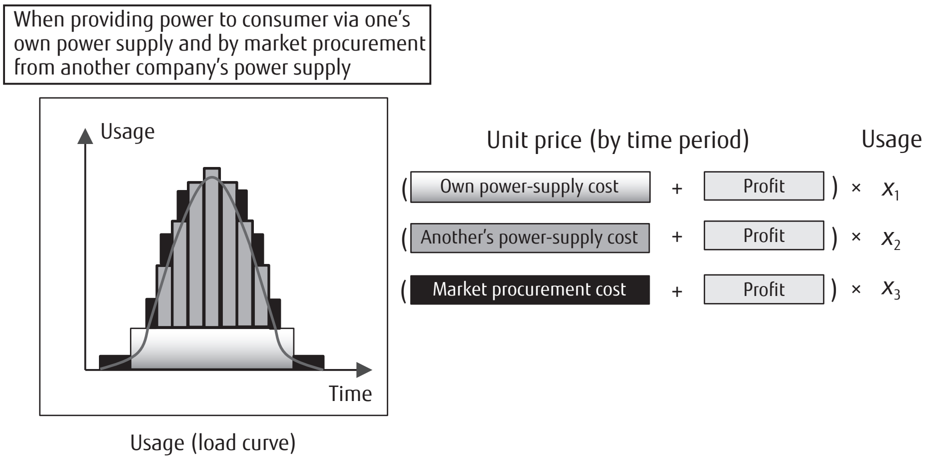

Figure 5
Real-time rate calculation.

will become a separate company with a neutral position in the market while the power-generation department and retail department will become separate companies with a competitive position in the market. Since work efficiency generally drops when a company splits up, an existing power company that has to compete with new entrants following full retail liberalization and department unbundling will need a mechanism that prevents this envisioned drop in work efficiency among its group companies (power generation, transmission/distribution, and retail).

That is, its core retail system will need to be structured so that it improves the efficiency of work spanning the traditional boundaries of those departments. This requirement is related to work flow, which means that two system measures in particular will be needed.

1) Loose coupling of business processes (ICT services) spanning different departments (message service processing)
2) Introduction of a flow engine for implementing a standardized workflow in which even new entrants can participate in

FUJITSU Software Interstage Service Integrator (ISI) middleware can be used to achieve the loose coupling of business processes, and the FUJITSU Software Interstage Business Operations Platform (IBOP) middleware can be used to achieve the workflow engine. The conceptual diagram in **Figure 6** shows how Fujitsu middleware can be used to make the work between group companies efficient by visualizing work through modeling and linking with existing systems.

5. Mechanism for adapting to environmental changes : migration from fully distributed cost method to rate-plan-specific demand forecasting and profit calculation method

Conventional electric power companies have been assessing costs and profits in relation to power generation and transmission/distribution in an integrated manner and have been setting unit prices for each rate plan on the basis of the fully distributed cost, as shown on the left in **Figure 7**. Since new entrants will be able to set unit prices lower than those of existing retail power companies, they will have an advantage in attracting customers.

Under these conditions, existing retail power companies must rethink the conventional way of calculating profit on the basis of the results for the entire power-supply area. They must instead determine whether they are profitable in units of rate plans or individual contracts and must reduce their prices. The workflow for planning new rate plans and the related functions are shown on the right in Figure 7.

In addition, a mechanism will be needed for quickly releasing new rate plans to meet the threat of new competing companies. This is because a highly competitive rate plan will not be effective if slow implementation enables competing companies to capture

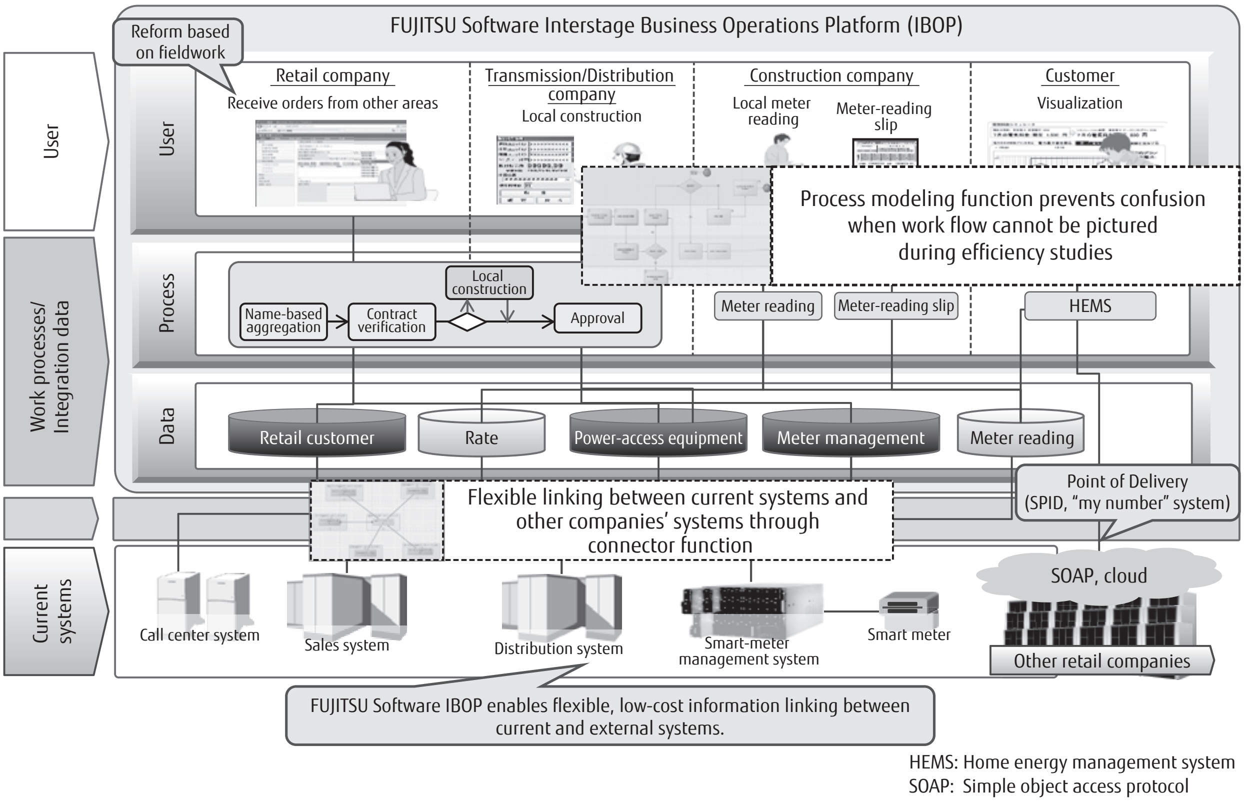

Figure 6
Increasing work efficiency between group companies.

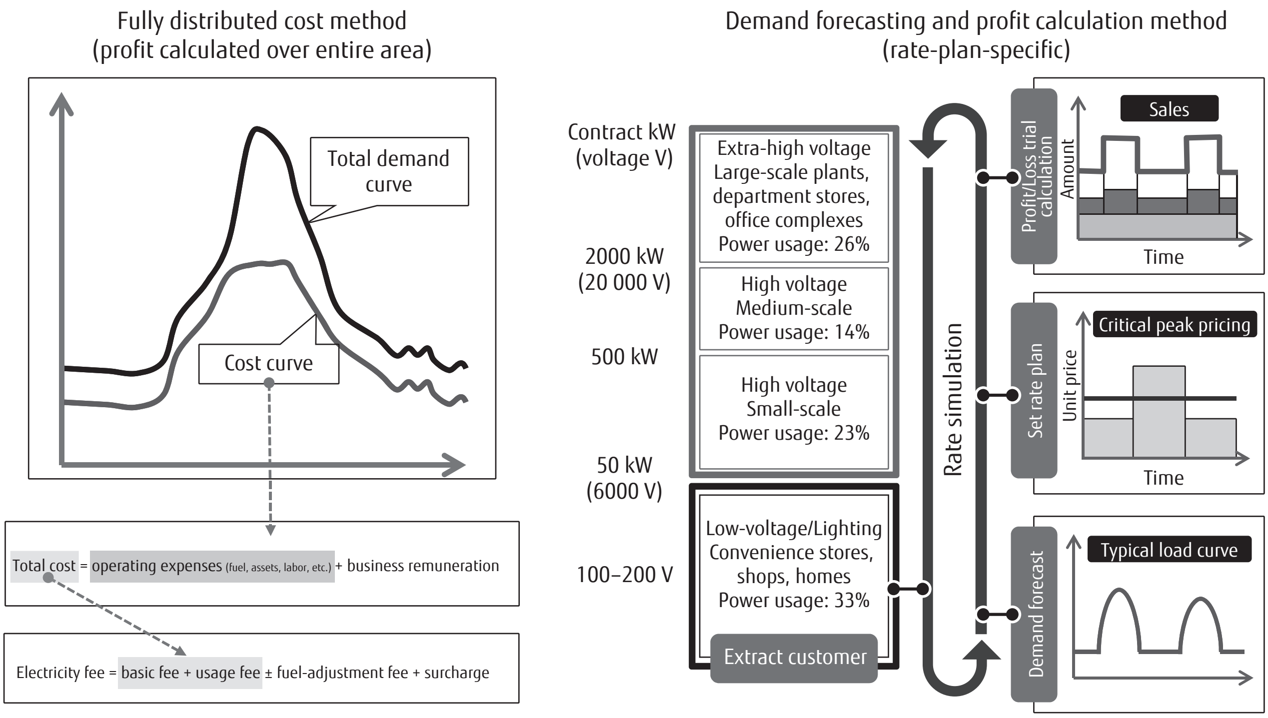

Figure 7
Fully distributed cost method vs. demand forecasting and profit calculation method.

the target consumers.

The work of planning new rate plans will therefore require a rate-plan-specific demand forecasting and profit calculation method that incorporates the capabilities (functions) listed below and a sales support system for quickly rolling out new plans.

1) Can determine power usage of each consumer for each time period
2) Can classify each consumer by usage curve
3) Can hypothetically set new unit prices for groups of similarly classified consumers
4) Can set power-generation and procurement costs for each consumer group by time period
5) Can execute rate simulations for each consumer and calculate profit for each rate plan from values set in functions 3) and 4)
6) Can use results of profit studies to quickly release a rate plan, implement it in the core system, and calculate charges.

The mechanism for quickly rolling out new rate plans is shown in **Figure 8**.

6. Conclusion

This paper described electricity retail solutions provided by Fujitsu and mechanisms for achieving them with the aim of resolving issues that are expected to arise with electricity systems reform in Japan.

In the fall of 2013, Japan's National Diet approved a bill for revising the country's Electricity Business Law toward electricity systems reform. However, the enactment of various regulations and standards for introducing the new system is not yet complete, and it is still difficult to envision exactly how the industry will change under this reform.

Against this background, Fujitsu plans to apply its extensive know-how in the electricity retail business and the results of surveying prior overseas examples in enhancing and expanding its electricity retail solutions. Our ultimate aim is to provide systems and services that satisfy the needs of our power-company customers in the electricity market.

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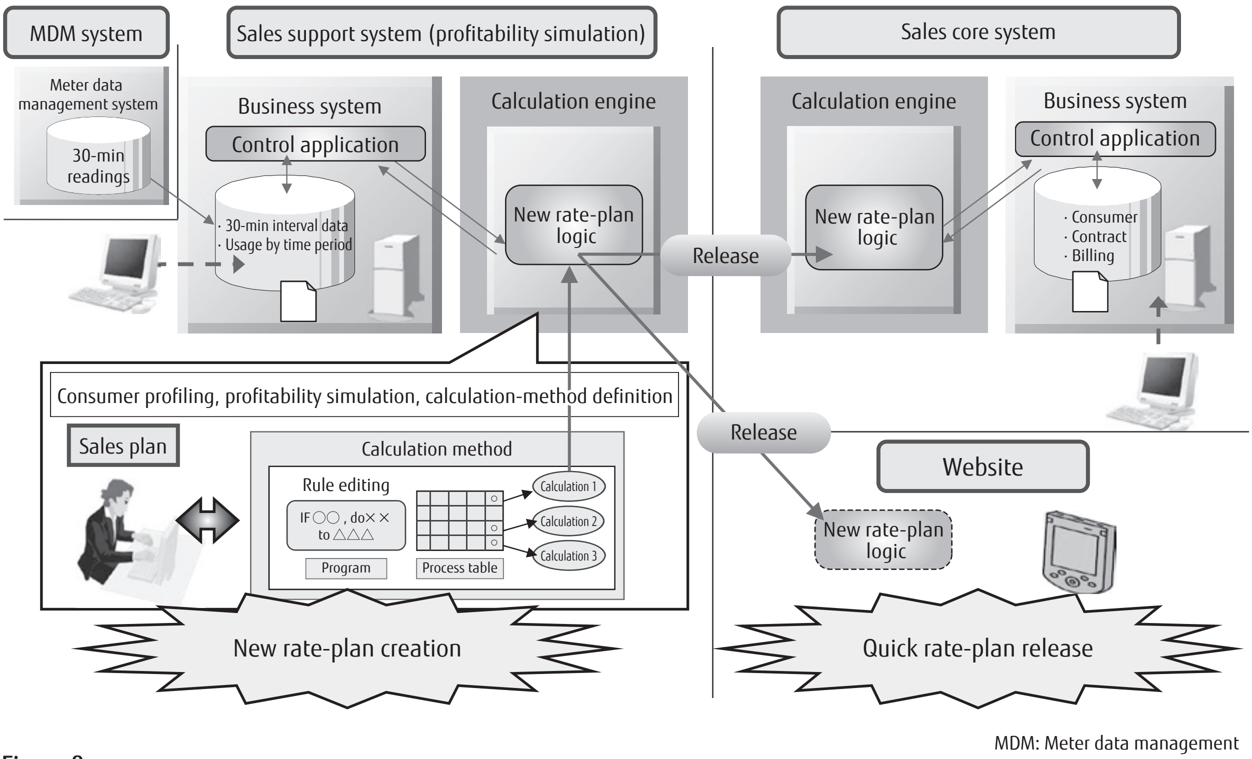

Figure 8
Mechanism for quickly rolling out new rate plans.

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